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Application of Project Management with the CPM Method in a House Construction Project

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Abstract
This study aims to apply the CPM in planning and controlling a one-story house construction project in Samarinda City. CPM is used to identify the critical path, which is a series of activities that have no float and directly affect the duration of project completion. The research method used was descriptive quantitative with a case study approach. Data was collected through field observations, structured interviews, and analysis of project documents such as the Cost Budget Plan (RAB) and time schedule. The results of the analysis showed that CPM was able to arrange the sequence of activities logically, determine the start and finish time of each activity, and identify the critical path with a total duration of 77 days. These findings show that CPM is effective in improving project time efficiency, optimizing resource allocation, and minimizing the risk of delays. The application of this method makes a real contribution to more structured construction planning, especially in small-medium scale projects such as the construction of a one-story house.

Keywords: Critical Path Method, Construction Project, Project Scheduling, Time Management

1. Introduction

In the world of construction, project management is one of the most crucial elements in determening the success of a project. Project management is not only related to the supevision of umplementation in the field, but also includes the process of planning, organizing, implementing, controlling, and evaluating all resources involved in the project. Project success is greatly influenced by how well project management is able to ensure that work is carried out on time, withing budget, and meets predetermined quality standards (Tusadiyah & Sukobar, 2022) [23]. According to p in practice, construction projects face various complex challenges such as time constraints, rising material prices, technical constraints, and labor risk. Therefore, a systematic management strategy is needed to harmonize all project components to keep it running according to plan. Effective project management is able to integrate various aspects ranging grom time scheduling, cost control, management of human and material resources, and risk management. The construction of subsidized houses for low-income people often faces challenges such as time and budget constraints, as well as demands for building quality and safety. In a study by Fendi & Amrina, (2021) [5], it was explained that the application of structured project management is very important in managing the construction of subsidized houses, from the planning to the control stage, to ensure that the project runs effectively and efficiently according to time, cost, and quality targets. Project management plays a role in coordinating all development activities, managing resources, and controlling risks that may arise during the construction process. Thus, the construction of houses with project management is not just a physical construction process, but also a structured effort to achieve social and technical goals through professional and measurable project management. House construction projects, although small to medium in scale, still require systematic management to avoid waste of resources, delays, and deviations from the original plan. One method commonly used in planning and controlling project time is the CPM (Mar'aini & Akbar, 2022; Iqrammah, 2022) [13, 10]. The CPM method allows project managers to identify the critical path of the entire set of project activities, so that it can be known which activities have time leeway and which do not. Network planning with critical path determination is one of the management techniques used to plan and control the implementation of a project.

It can show the relationship between activities and determine important/critical times in project activities (Mar'aini & Akbar, 2022) [13]. CPM is a network study that aims to minimize the entire project cost by reducing or accelerating the total project completion time (Mar'aini & Akbar, 2022b) [13]. A 1-storey house construction project is a type of project that is often found in the community, whether in the form of private houses, commercial houses, or as part of small-scale housing projects. Although seemingly simple, the construction of a single-storey house consists of many interdependent activities, such as foundation work, structure, architecture, and finishing. When these projects are not managed properly, delays in just one activity can have an impact on the entire project schedule. According to Saputra *et al*., (2024) [20] comprehensively discussed the process of preparing a construction project work network using the CPM approach. This method starts from identifying all activities in the project, determining the duration of each activity and preparing a network diagram to describe the logical sequence and dependence between activities. The application of CPM has proven to be effective in planning and controlling construction projects, including one-story house construction projects which, although small in scale, still have activity complexity (Rakasyiwi *et al*., 2022; Wofuru-Nyenke, 2024) [15, 24] (Gumilar & Koswara, 2023). CPM is used to identify the critical path, which is a series of activities without float, so a delay in one of these activities will directly affect the entire project (Kim, 2020; Sain, 2025) [12, 6]. By analyzing the critical path and utilizing non-critical activities that have float, project managers can efficiently reschedule and redistribute resources. In addition, acceleration techniques such as crashing can be used to optimally adjust time and cost. The study by (Kim, 2020) [12] introduced a generalized resource-constrained CPM that improves the limitations of the standard CPM in resource-constrained conditions, while research by (Qomariyah & Hamzah, 2013) [14] Research shows that the application of CPM effectively accelerates project duration by up to 10%. For example, in an office construction project, the use of the CPM is effective in accelerating the project duration by up to 10%. However, there is still a research gap, especially in the application of the CPM method to one-story house construction projects in urban communities that are relatively small in scale and often managed traditionally without a systematic project management approach. There are not many studies that specifically examine the application of the CPM method in 1-storey house construction projects with case studies in certain areas, especially in Samarinda City

Based on this background, this research was conducted with the object of a 1-story house construction project in Samarinda City. This study aims to apply the CPM in planning and controlling house construction projects, in order to determine the critical path, optimal implementation time, and effectiveness of time management that can be achieved through this method. It is expected that the results of this research can be a practical reference in managing small and medium construction projects more professionally and efficiently.

2. Methods

This research applies a quantitative descriptive approach to analyze the application of the CPM in the project Construction of a one-story house in Pinang Bahari housing in Samarinda starting in October 2024. This approach was chosen because it allows accurate numerical data representation regarding the sequence of project activities, duration estimation, as well as the identification of critical paths that can affect the overall project schedule. CPM is widely recognized as being able to improve project scheduling efficiency by identifying critical activities that should be prioritized (Rakasyiwi *et al*., 2022; Wofuru-Nyenke, 2024) [15, 24]. The research data consisted of primary data collected through direct observation, structured interviews with project implementers, and documentation of field activities; and secondary data in the form of planning documents such as time schedules, cost budget plans (RAB), and project technical drawings (Halim *et al*., 2024) [7]. The analysis was conducted through the application of the CPM method, including the stages of identifying all project activities, determining the duration, and analyzing the dependency between activities to develop a work network diagram. This diagram becomes the basis for calculating the earliest and latest start and finish times, thus enabling the identification of the project critical path (Hartawan *et al*., 2024; Kadang *et al*., 2024) [8, 11]. The CPM results are compared with actual implementation data in the field to identify time deviations and evaluate the effectiveness of the planning schedule. This evaluation aims to formulate time control strategies that allow project acceleration without significantly increasing costs (Danfulani *et al*., 2023; Tohari & Suhasto, 2023) [3, 22]. Various contemporary studies show that proper application of CPM can shorten project completion time, improve resource efficiency, and provide flexibility in adjusting to project (Bosch-Rekveldt & Bakker, 2021; Hong, 2024; Ramani *et al*., 2022) [2, 9, 16].

1. Problem formulation

This study formulates issues related to the suboptimal management of time in single-story house construction projects. The focus is on how the application of the CPM can identify critical paths and improve the efficiency of project implementation.

2. Literature search

The author searched for information sources in the form of research journals relevant to the application of the CPM method in construction project management.

3. Data evaluation

The author evaluates the contents of the journals obtained to ensure that the data is relevant to the focus and objectives of the research.

4. Data analysis and interpretation

The author analyzed the research data using content analysis techniques to assess the suitability of the results with the topic and timing of implementation, then compiled it into a scientific article.

3. Results and Discussion

1. Results

At this stage, the researchers compiled a house construction project planning using the , according to Rembulan & Yuhao, (2023) is a dynamic system, which will continue to be updated according to the progress of the project. This method uses a single time estimation method, where time is considered a certain time. In project management, theis a basic and very important tool, referring to the sequence of

network terminal elements. The essence and key of this method is to find out each path composed of project activities and the critical path between them. In project management, the basic idea of preparing a network plan is to find critical paths in large network diagrams, prioritize resources for each major activity, exploit potential, and take appropriate action to minimize the time required. As described by Sutanto, (2018), identification of activities and dependencies between activities is the main basis for applying the . The preparation is carried out by identifying all work activities based on the Cost Budget Plan (RAB) data, then mapping the dependency relationship between activities, the duration of each job, and compiled in the form of an activity table. After the preparation of the table, followed by the creation of a network diagram and the calculation of the earliest start time, the earliest finish time, the latest start time, and the latest finish time.

Table 1: Planned Project Activities

Name	Duration	Start Date	Finish Date	Predecessor
Planned Project Activities	4	30/10/2024	04/11/2024	-
The following is the preparation of the Project Activity Table using the	16	05/11/2024	26/11/2024	A
	17	27/11/2024	21/12/2024	B
Roof Work	11	23/12/2024	08/01/2025	C
Ceiling Work	3	9/01/2025	14/01/2025	D
Floor Work	8	15/01/2025	24/01/2025	E
Mechanical & Electrical Work	15	27/01/2025	14/02/2025	F
Garden & Landscape Work	4	17/02/2025	21/02/2025	G

Source: Data Processed

Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added The table contains a series of main activities in the type 80 house construction project, including job names, work duration in days, start date, finish date, and dependency relationships between activities (predecessor). This data becomes the basis for preparing a network diagram with theCPM which is used to plan and manage project time in a more structured manner. The information displayed allows the project team to thoroughly analyze the sequence of activities and determine the trajectory of activities that most affect the total project duration, namely the critical path. Activities that are on the critical path have no float, so a delay in one of these activities will have a direct impact on the overall project delay. Meanwhile, other activities that are outside the critical path still have flexible time or slack. By understanding these durations and dependencies, project managers can identify activities that should be prioritized for supervision and devise appropriate acceleration strategies if needed, without disrupting the overall project schedule. Therefore, this table becomes one of the important components in the process of planning and controlling time in construction projects.

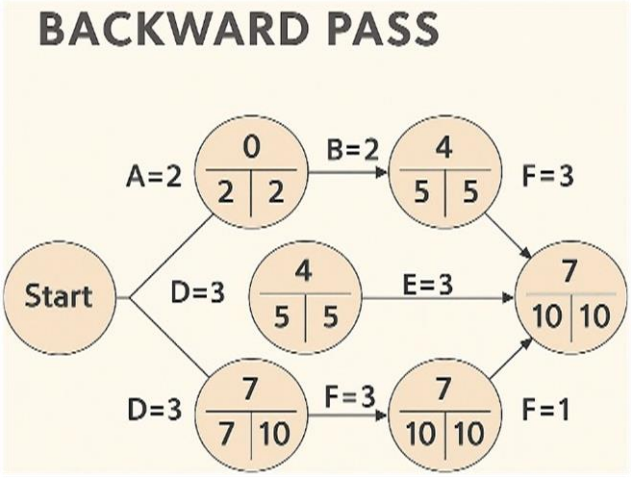
Table 1.2: Critical Path Calculation Results

Code	Activity	Duration	Predecessor
A	Preparatory Work	4	-
B	Earthwork & Foundation	16	A
C	Wall Work	17	A
D	Roof Work	11	B,C
E	Ceiling Work	3	D
F	Floor Work	8	E
G	Mechanical & Electrical Work	15	F
H	Garden & Landscape Work	4	G

Source: Data Processed

From the calculation results, the activity trajectories that form the critical path of the project are obtained, namely:
A → B → E → F → I → J → K → L → M → S → T → U → V → W → X → AD → AF,
with a total duration of 77 days. This means that a delay in any one activity in the sequence will directly affect the completion of the entire project. In contrast, other activities that are not on the critical path have slack that allows for more flexible completion without affecting the overall project deadline. This finding is in line with research conducted by Anggraini *et al*., (2025) [1] on optimizing the time and cost of housing projects using theCPM and S-Curve, where CPM has proven effective in preparing project schedules and providing an accurate reference for contractors in determining estimated completion times.

Critical Path Backward Pass
The following is theBackward Pass Diagram.



Source: Data Processed

Fig 1: Backward pass

The diagram above shows the start and finish time values calculated from the initial project endpoint. The numbers inside the nodes represent the initial start time, initial finish time, and duration. Through this backward calculation, the late start and late finish values for each activity are obtained. Based on these results, the critical trajectory of the project is: start→ A→ B→ E→ F→ End The total project duration based on the critical path is 10 days. All activities on this path have a slack of 0, so a delay in any of the activities will

directly impact the overall project completion delay.

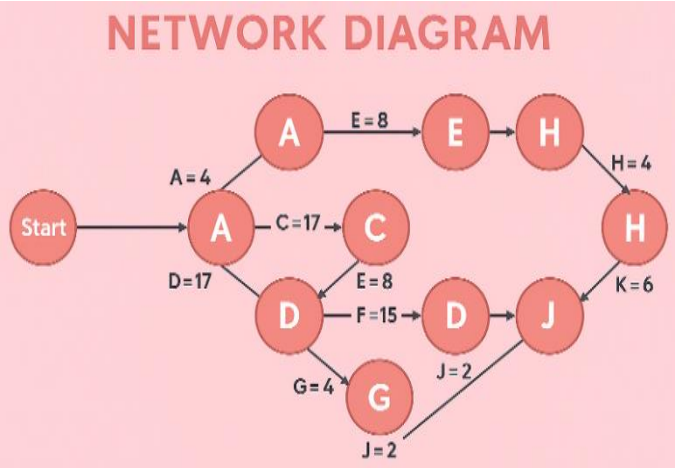
Benefits of Using CPM

TheCPM method makes a significant contribution to the project planning and control process, especially in the construction field. One of its main advantages is its ability to identify activities on the critical path, which is a series of activities that have no float. If there is a delay in one of these activities, the entire project schedule will be affected (Yap *et al*., 2021) [25]. In addition, CPM also makes it easier to manage resources because it is able to show activities that must be prioritized, so that the distribution of labor and materials can be done more effectively (Farah *et al*., 2023a) [4]. (Farah *et al*., 2023b) [4]. In addition, the application of CPM also supports the preparation of a more realistic project schedule because it is based on a systematic analysis of duration and dependency between activities (Anggraini *et al*., 2025b) [1]. This method also plays an important role in monitoring project implementation because it facilitates evaluation of work progress and identifies possible deviations from the planned schedule (Rofi, 2024) [18]. Overall, CPM is an effective project management tool in ensuring the timeliness of completion and efficiency of the construction process.

Visual Interpretation of Critical Path

The figure shows a network diagram that represents the project workflow based on the sequence of activities, duration, and dependency relationships between tasks. The diagram starts from the "Start" node and illustrates the project stages through nodes labeled with letters such as A, C, D, E, G, H, J, and K, where each symbolizes a specific activity in the project execution.

The arrows between nodes illustrate the logical dependency relationships between activities, complete with information on the duration of work in days (for example: A = 4 days, C = 17 days, and so on). These paths form a series of activities from the early stages to the end of the project, which can be further analyzed to determine the critical path. This diagram helps identify activity paths that have no float, so any delay in those activities will directly impact the overall project delay. In the context of project time management, the critical path is an important component in decision-making and schedule control.



Source: Data Processed

Fig 1: Network Diagram

4. Discussion

Virtual Reality (VR) based learning media has been successfully developed and tested in previous research. The learning media was then tested to determine the characteristics of the developed media as well as expert assessments and student responses.

Learning media gets a feasible category if it has an average score from experts of 76% ≤ x ≥ 100%. Validation by material experts on *Virtual Reality (VR)-based learning media is carried out to measure the feasibility of the media developed according to the assessment of aspects of suitability of objectives, suitability of curriculum, content of material, and media in learning. Validation by media experts on Virtual Reality (VR)* -based learning media is carried out to measure the feasibility of the media developed based on aspects of media appearance, content feasibility, and object appearance.

Assessment of student responses to *Virtual Reality* (VR)-based learning media is carried out to measure respondents' interest in the products that have been developed. The greater the percentage value obtained by the researcher, the better the product developed for use by students as learning media. Learning media is declared very good based on student responses if it obtains an average score of 76% ≤ x ≥ 100% (Arikunto, 2010). The results of the assessment can then be described as follows:

1. Identification of Critical Path Through the application of the Critical Path Method (CPM), researchers were able to identify the critical path in a single-story house construction project. This path includes a series of activities that have no time float, meaning that a delay in any one activity will directly impact the overall project schedule.
2. Project Duration The critical path identified has a total duration of 77 days, starting from preparatory activities to final work such as landscaping. This information serves as the basis for more realistic scheduling and more accurate time control.
3. Flexibility in Scheduling Non-Critical Activities Activities that are not on the critical path have slack time, so their completion can be scheduled more flexibly without affecting the project deadline. This gives the project team room to reallocate resources more efficiently.
4. Project Acceleration Strategy If delays occur, project managers can apply acceleration techniques such as crashing or fast tracking to activities on the critical path. This step allows the project to remain on schedule without causing significant cost overruns.
5. Consistency with Previous Research These findings are consistent with previous research (e.g., Anggraini *et al*., 2025; Hartawan *et al*., 2024) [1, 8] stating that CPM is effective in improving time efficiency and resource control, particularly in small- and medium-scale construction projects.
6. Practical Contribution Overall, the application of CPM in this single-story house construction project has proven to enhance project management effectiveness, minimize the risk of delays, and support the implementation of a more professional and timelier project.
7. CPM enables project managers to systematically monitor progress by knowing the earliest and latest start and finish times for each activity. This helps reduce the risk

of delays and improves control over time deviations in the field.

5. Conclusion

Based on the results of the study, the application of theCPM in a one-story house construction project in Samarinda proved to be effective in systematically planning and controlling project implementation time. By identifying a critical path consisting of activities without float, this method allows project managers to prioritize important work, manage resource allocation efficiently, and minimize the risk of delays. CPM also provides important information related to the earliest and latest start and finish times for each activity, so it can be used as a basis for evaluating project progress and making strategic decisions in the face of schedule deviations. The results of the analysis show that the project's critical path has a total duration of 77 days, and a delay in any of the activities in the path will have a direct impact on the overall delay in project completion.

6. Thank-You Note

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